

PROCEEDINGS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

FOURTH SERIES

Vol. XXIX, No. 8, pp. 273-313, 1 map, 3 plates

July 10, 1958

A NEW FISH, *CHAETODON FALCIFER*,
FROM GUADALUPE ISLAND, BAJA CALIFORNIA,
WITH NOTES ON RELATED SPECIES¹

BY

CARL L. HUBBS and ANDREAS B. RECHNITZER

Scripps Institution of Oceanography

CONTENTS

	<i>Page</i>
Introduction	274
A New Species from Guadalupe Island	275
<i>Chaetodon falcifer</i> , Hubbs and Rechnitzer, new species	275
Type Specimen	275
Collecting Notes and Habitat Data	275
Distribution	278
Distinctions	279
Relationships	282
Diagnosis	285
Description of Fins	285
Scales and Lateral Line	286
Body and Head Characters	288
Osteological Features	289
Coloration	291
Measurements	294
Derivation of Name	294

¹ Contributions from the Scripps Institution of Oceanography, New Series

CONTENTS—Cont.

	Page
Distinctive Characters and Relationships of the Three Other Eastern Pacific Chaetodontines	295
<i>Chaetodon humeralis</i> Günther	295
<i>Heniochus nigrirostris</i> (Gill)	296
<i>Forcipiger longirostris</i> (Broussonet)	299
Taxonomic Notes on Atlantic Relatives of <i>Chaetodon falcifer</i>	300
<i>Chaetodon aya</i> Jordan	300
<i>Chaetodon marcellae</i> Poll	304
<i>Prognathodes aculeatus</i> (Poey)	304
Systematic and Zoogeographical Conclusions	307
Literature Cited	309

INTRODUCTION

Isla Guadalupe, an oceanic island rising from deep water off Baja California, about 225 nautical miles south and slightly west of San Diego, and separated by 133 miles from the nearest other land (Isla San Gerónimo), is proving to be characterized by a high incidence of endemism in its littoral marine as well as in its terrestrial biota. The marine endemics include a considerable number of littoral fishes. A few of these, including two gobi-eooids discovered by the senior author and recently described by Briggs (1955: 79–80 and 100–101, figs. 5, 95, and 100), have been proposed as full species. Others remain to be named, either as species or subspecies (the problem is currently under study by the senior author and Eric Godwin Silas). Of the apparently endemic species perhaps the most strikingly distinctive is the butterflyfish described in this paper.

Except as noted, the systematic methods, especially of counting and measuring, are those proposed by Hubbs and Lagler (1952). Angles were measured as proposed by Hubbs (1946).

We are indebted to a number of colleagues for assistance in the examination of material, for data, and for suggestions in the presentation. In particular, we acknowledge such help from Leonard P. Schultz of the United States National Museum, who verified our conclusions regarding the value of the lateral-line character and the placement of the species *nigrirostris*, who made material in the National Museum freely available, and who had two photographs prepared. We are similarly grateful to Loren P. Woods of the Chicago Natural History Museum, who, like Schultz, provided much information on the lateral-line characteristics of many species and offered valued suggestions regarding the taxonomy of the group, which he has extensively studied. Woods also loaned us specimens of *Chaetodon aya*. We express appreciation also to Boyd W. Walker, our colleague at the Uni-

versity of California at Los Angeles, who has made available extensive material of the previously known eastern Pacific chaetodontines and has otherwise been of help and encouragement in the preparation of the paper. Robert L. Wisner made the X-ray photograph reproduced as plate I, figure 2. Max Poll of the Koninklijk Museum van Belgisch-Kongo has allowed the reproduction of the type figure of *Chaetodon marcellae*. W. I. Follett and Lillian Dempster of the California Academy of Sciences have assisted generously in the processing of the manuscript.

A NEW SPECIES FROM GUADALUPE ISLAND

Chaetodon falcifer Hubbs and Rechnitzer, new species.

(Plate I.)

TYPE SPECIMEN

A large adult, 138 mm. in standard length, collected at a depth of 100 feet on the east shore of Guadalupe Island, off Baja California, México, on November 16, 1954; Cat. No. 20734, Department of Fishes, California Academy of Sciences.

COLLECTING NOTES AND HABITAT DATA

The only known specimen of this species (pl. I, fig. 1) was speared by Rechnitzer during a deep-poisoning operation on November 16, 1954, supplemented with detonation of Primacord on November 17, in a cove on the generally calm eastern shore of the volcanic island, about 0.5 mile north of Morro Sur (South Bluff), at 28° 53' 24" N. Lat., 118° 15' 00" W. Long. (as measured on Hydrographic Office Chart 1688 (1956); on the older chart, 1681, the island was misplaced 1.5 mile to westward and 0.6 mile to southward). Rechnitzer swam down with aqualung equipment to try to collect a bright orange-yellow fish (a pomacentrid?) that he had seen while applying the derris-root paste at a depth of about 20 feet. Failing to relocate that specimen in the clouded water, he went lower, to the rocky bottom at a depth of about 100 feet, where, about a foot off the bottom, under a slight ledge at the base of the vertical underwater cliff, he saw, in the extremely clear water, and speared, the magnificent butterflyfish we are describing.

Where the fish was obtained, plants, other than encrusting coralline algae, were few and scattered. In shallower water there was much attached *Sargassum* and other algae and some eelgrass (*Zostera*). The temperature was recorded by one of the divers as 65° F. from top to bottom. In addition to rock there was some sand and gravel on the level bottom, which was about 100 feet deep. The vertical rock wall was penetrated by deep recesses and vertical crevices, which provided excellent cover for reef fishes.

Bearing in mind the favorable habitats at this station and the large

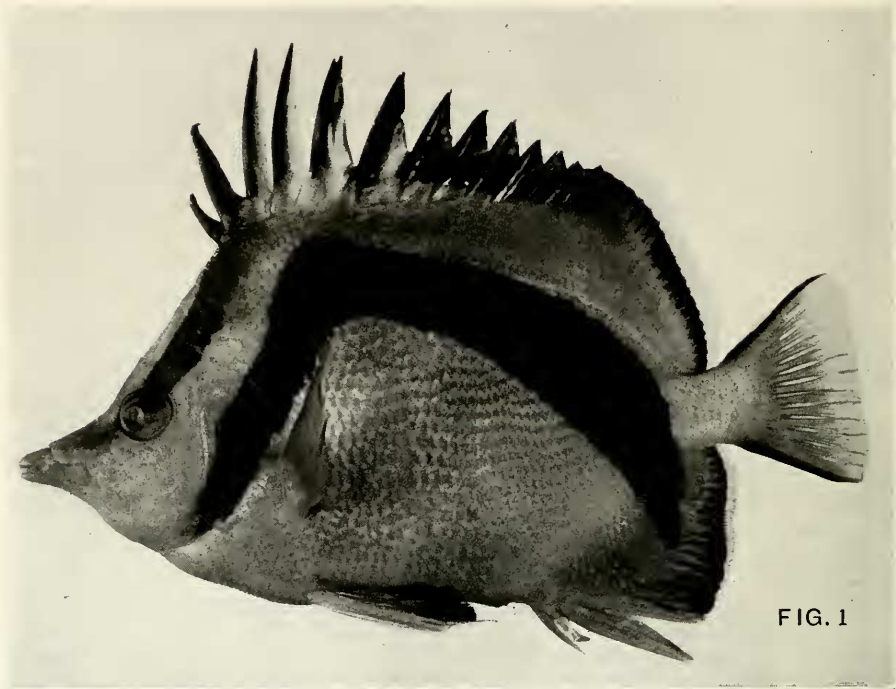


FIG. 1

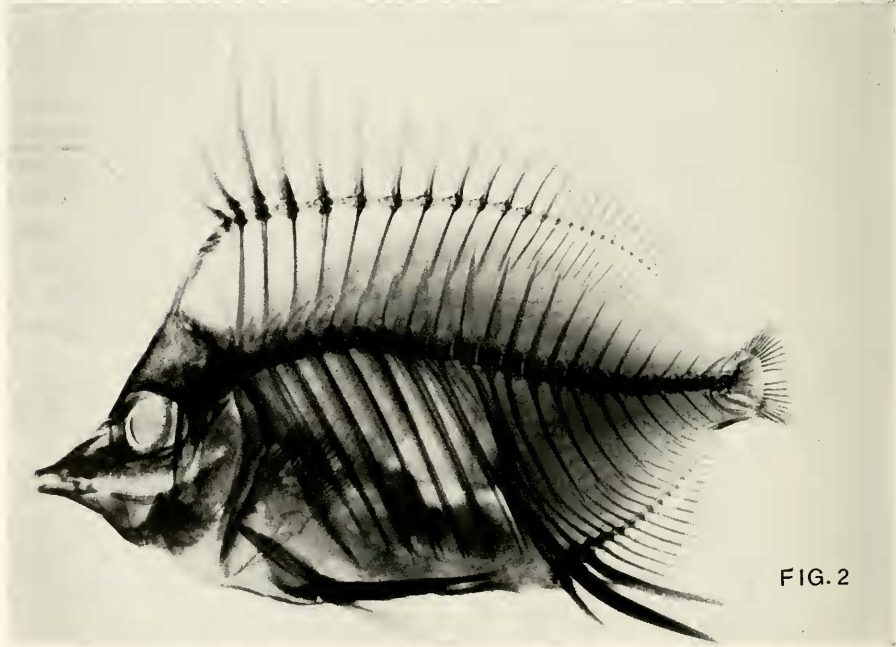


FIG. 2

party of collectors (thirteen, including six with aqualungs), it is not surprising that a considerable proportion of the depauperate littoral fish fauna of Guadalupe was taken with the *Chaetodon*. The thirty-three species listed below were included in the collection and are therefore to be listed as approximate associates of the butterflyfish. Species only observed are marked with an asterisk. Endemics are marked with a dagger.

Sternoptychidae	Girellidae
<i>Vinciguerria lucetiae</i> Garman	<i>Girella nigricans</i> (Ayres)
Exocoetidae	Scorpididae
* <i>Cypselurus californicus</i> (Cooper)	<i>Medialuna californiensis</i> (Steindachner)
Apogonidae	Scorpaenidae
<i>Apogon guadalupensis</i> † (Osburn and Nichols)	<i>Scorpaena guttata guadalupae</i> Fowler (occurs also in Gulf of California)
Serranidae	<i>Scorpaenodes xyris</i> (Jordan and Gilbert), possibly differentiated
<i>Paralabrax clathratus</i> (Girard)	Cottidae
Atherinidae	<i>Artedius creaseri</i> (Hubbs), possibly differentiated
<i>Atherinopsis californiensis</i> subsp.†	Gobiidae
<i>Atherinops affinis guadalupae</i> †	<i>Lythrypnus zebra</i> (Gilbert), possibly differentiated
Hubbs	<i>Lythrypnus dalli</i> (Gilbert), possibly differentiated
Carangidae	Clinidae
* <i>Seriola dorsalis</i> (Gill)	<i>Alloclinus holderi</i> (Lauderbach)
<i>Trachurus symmetricus</i> (Ayres)	<i>Heterostichus rostratus guadalupensis</i> † Hubbs
Branchiostegidae	<i>Gibbonsia elegans erroli</i> † Hubbs
<i>Caulolatilus princeps anomalus</i> (Cooper)	<i>Gibbonsia norae</i> Hubbs, also on San Benito Islands
Embiotocidae	Tripterygiidae
<i>Embiotoca</i> sp., possibly differentiated	<i>Enneapterygius</i> sp., not endemic
<i>Damalichthys</i> sp.†	Brotulidae
<i>Brachyistius aletes</i> † (Tarp)	<i>Eutyx diagrammus</i> Heller and Snodgrass, also on Galápagos Islands
Pomacentridae	Balistidae
<i>Chromis punctipinnis</i> (Cooper), somewhat differentiated	<i>Xanthichthys lineopunctatus</i> (Hollard)
<i>Azurina hirundo</i> † (Jordan and McGregor)	
<i>Hypsypops</i> sp.†	
Labridae	
<i>Bodianus diplotaenia</i> (Gill)	
<i>Pimelometopon pulchrum</i> (Ayres)	
<i>Halichoeres semicinctus</i> (Ayres)	
<i>Oxyjulis californica</i> (Günther), possibly differentiated	

PLATE I

Figure 1. Holotype of *Chaetodon falcifer*, 138 mm. in standard length, from Guadalupe Island, México. Photo by Scripps Institution.

Figure 2. X-ray photograph, by Robert L. Wisner, of holotype of *Chaetodon falcifer*. Print by Scripps Institution.

The collecting at this station (SIO 54-219) was a joint operation of two parties, largely from the Scripps Institution of Oceanography, led, respectively, by the junior author on the Institution's Research Ship *Paolina T*, and by the senior author on the Research Ship *Orca*, of the J. W. Sefton Foundation. Thanks are due to all members of the dual expedition, especially to Joseph W. Sefton, Jr., who, often and graciously, made the *Orca* available for biological explorations.

DISTRIBUTION

It is possible, indeed highly probable, that this apparently deep-water *Chaetodon* is much commoner about Guadalupe Island than the collecting of only one specimen would indicate. However, no other specimen has been seen, despite the fact that, of late, the island has been subjected not only to rather intensive collecting but also to a considerable amount of aqualung diving by several experienced and observant divers, including Conrad Limbaugh. During the expedition of November, 1954, six divers with self-contained underwater breathing apparatus were under water much of the time during seven consecutive days. The center of abundance of the species may well be deeper than 100 feet (as seems to be true of the related Atlantic species); or, it may occur chiefly on the western shore of the island, where the surf is usually strong and where collecting below tidal limits has been very limited.

It is also possible, though we think rather improbable, that the species occurs farther south, either along the mainland or on the Revillagigedo Islands. It has not been included among the chaetodontids taken during the extensive collecting in those areas in recent years, particularly by parties working under or for Boyd W. Walker of the University of California at Los Angeles and John E. Fitch of the California Department of Fish and Game. A considerable amount of more or less deep-water poisoning has been included in those operations. For these reasons, *Chaetodon falcifer* may be listed, provisionally at least, among the endemic fishes of Guadalupe Island. The interpretation of *C. falcifer* as a relative of the deep-water Atlantic species, *C. aya* and *C. marcellae*, weakens but hardly destroys the indication of endemicity.

Even though endemic, *Chaetodon falcifer* is to be included among the tropical elements in the intermixed warm-temperate and tropical fish fauna of Isla Guadalupe. In the eastern Pacific it probably represents the northern limit in the present distribution of the tropical family Chaetodontidae. The qualification "present" is used because, about one hundred years ago, when the fauna of southern California was distinctly more tropical than at present (Hubbs, 1948), *Chaetodon humeralis* Günther seems to have occurred at

San Diego. We are informed by Leonard P. Schultz that two specimens of that species in the United States National Museum are recorded as having been collected by Lt. Trowbridge at San Diego, California. The low catalog number (3170) indicates that the specimens were in fact entered in the collection nearly 100 years ago. Lt. W. P. Trowbridge was one of the most effective of the West Coast collectors on the Pacific Railroad Surveys. Somehow the species escaped inclusion in Girard's reports on the fishes collected by these surveys. Presumably the specimens came to light after the bulk of the collections had been studied and cataloged, for the number is higher than those recorded for the species reported by Girard. In this connection it may be noted that Girard (1858: 338) referred to other specimens from San Diego that had become "mislaidd in the moving of the Smithsonian collections from one end of the building to another a few months since." Some slight doubt regarding the validity of the San Diego record can not be dispelled, but we believe that *C. humeralis* is to be added to the list of tropical fishes that occurred at San Diego during the warm period a century ago.

DISTINCTIONS

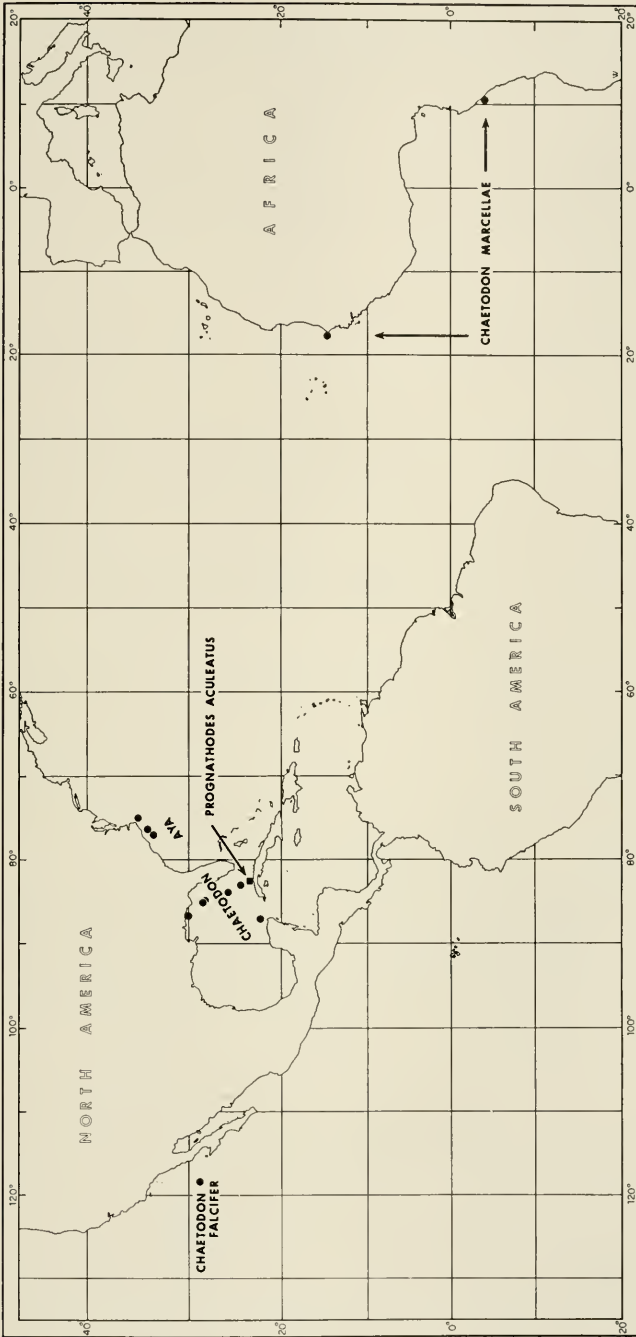
Chaetodon falcifer is not closely related to any of the three chaetodontines already known from the eastern Pacific. It does not belong in the same subgenus as *C. humeralis* Günther (1860: 19-20; 1869: 419, pl. 65, fig. 3), which is the only one of the three that we retain in the genus *Chaetodon*. It agrees with that species, as well as with the two others, in the high spinous dorsal with deeply incised interspinal membranes, but it has a much sharper and more produced snout and very much smaller scales, and the scale rows on the middle of the trunk are subhorizontal and those above the lateral line are parallel with the lateral line (instead of being strongly oblique in each area). Furthermore, the coloration is strikingly different, and there are numerous trenchant distinctions in the bony and scaly structures of the head, and in the squamation of the caudal fin (see pp. 295-296).

The Guadalupe species differs even more significantly, we believe, from the other eastern Pacific form currently referred to *Chaetodon*, namely *C. nigrirostris* (Gill). In that species, as is indicated later (pp. 296-299), the lateral line continues to the caudal base: a character that seems to call for its placement in another genus. Provisionally, we refer it to the genus *Heniochus*. *Chaetodon falcifer* and *Heniochus nigrirostris* differ in many other respects, as in coloration, in the squamation of the head, in the characters of the gape and lips, etc. The differences can be appreciated by comparing the following description of *C. falcifer* with the descriptive notes on *H. nigrirostris* (pp. 296-297).

When compared with *Forcipiger longirostris* (Broussonet), *C. falcifer* is seen to differ not only in the much less extremely produced beak, but also in the lateral-line character, in which *Forcipiger* and *Heniochus* agree, and in many features of coloration.

Inasmuch as some Indo-Pacific fishes, including one of the three eastern Pacific chaetodontines, have hurdled the broad barrier between the central Pacific islands and the New World (Ekman, 1953; Myers, 1941, and others) to become established in the Panamais fauna, *C. falcifer* has been compared with descriptions and figures of the multitudinous Indo-Pacific species of the Chaetodontinae. In this comparison numerous treatises have been consulted, including Bloch (1796), Cuvier (in Cuvier and Valenciennes, 1831), Günther (1860), Bleeker (1876a-1878), Jordan and Fowler (1902), Jordan and Evermann (1905), Jordan and Seale (1906), Kendall and Goldsborough (1911), Ahl (1923), Herre and Montalban (1927), Fowler (1928, and supplements), Fowler and Bean (1929), Weber and de Beaufort (1936), and Munro (1955). Also checked were species listed in the *Zoological Record* as having been published since the appearance of Ahl's monograph in 1923. Nothing corresponding closely with *C. falcifer* has come to light. It is concluded, therefore, that this species is not a stray from the present Indo-Pacific fauna.

On comparing *C. falcifer* with the Atlantic species of the genus, we find marked differences, but many characters shared with *C. aya* Jordan of the western Atlantic and *C. marcellae* Poll of the eastern tropical Atlantic (see pp. 300-304). There are consistent differences in the color marks. In the Pacific species the preocular part of the first band runs almost horizontally along the upper part of the side of the snout, rather than obliquely across the front part of the cheek just behind the mouth, and the posterior mark has a scythelike form with an anterior arm extending down to the opercular region, rather than being confined to a simple bar running obliquely downward and backward across the body from near the middle of the spinous dorsal (in *C. aya*), or subvertically downward from the end of the first dorsal (in *C. marcellae*). Furthermore, the scales are much finer in *C. falcifer* than in the Atlantic species, and there are many other, minor differences. A careful comparison of the type of *C. falcifer* with the 17 available specimens of *C. aya* discloses the numerous differences outlined in table 1. *Chaetodon falcifer* apparently differs from *C. marcellae* in most of the characters that distinguish it from *C. aya*.



Map 1. Known record stations for *Chaetodon falcifer* and allied species. The record station for one specimen (C.N.H.M. 64369) was received too late for inclusion, but essentially coincides with the northernmost station plotted.

Table 1. Comparison of *Chaetodon falcifer* with *C. aya*

	<i>Chaetodon falcifer</i>	<i>Chaetodon aya</i>
Dorsal soft-rays	21	17 to 19
Anal soft-rays	16	14 to 16, usually 15
Pectoral rays	15	13 to 15, usually 14
Scale rows, straight line ¹	51 to 53	32 to 38
Scales in first row above lateral line ²	64 to 66	27 to 36
Pores in lateral line ³	44 to 46	23 to 32
Scales from dorsal fin to lateral line ⁴	15	9 to 12
Scales from anal fin to lateral line ⁴	26	17 to 21
Scales around caudal peduncle ⁵	30	20 to 26
Lateral line ends:	Close to end of soft dorsal	Below front part of soft dorsal ⁶
Main marking on body ⁷	Scythe-shaped, with extension onto opercles	Oblique band, extending onto spinous dorsal
Band below eye extending:	Along side of snout	To just back of upper jaw
Dorsal and anal fins	With much black, and a definite light border	Almost clear, except on extension of bars; no definite light edge
Upper and lower borders of caudal fin	Largely blackish	Not blackened
Angle, body axis and margin of soft dorsal ⁸	72°	75° to 87°
Maximum known size	138 mm.	98.5 mm.

RELATIONSHIPS

We have not been able to allocate *C. falcifer* with complete assurance in any of the named subdivisions of *Chaetodon*, as these have been characterized in various published revisions (subsequent authors have based their groupings, though not their nomenclature, largely on the subgeneric divisions proposed or accepted by Bleeker from 1876 to 1878).

When checked with Ahl's monographic revision of 1923, *falcifer* is seen

¹ Rows crossing a straight line from scapular process behind upper end of gill opening to caudal flexure; for this and for all other paired series, both sides were counted on all specimens.

² Including all scales that impinge above on a lateral-line scale.

³ Including occasional unpored scales definitely in the lateral-line series.

⁴ From edge of sheath at side of first spine in an oblique row to but not including the lateral line.

⁵ Scales in not quite overlapping position around narrowest part of peduncle.

⁶ Ending rarely, on one side only, on vertical passing slightly before visible front of soft dorsal or a little behind middle of soft-dorsal base.

⁷ When considering colorational characters, compare plate I, figure 1 with plate II, figure 1 and plate III, figure 1.

⁸ Angle between body axis (from front of snout to middle of caudal base) and a symmetrical tangent to the rounded margin of the soft dorsal fin.

to agree essentially with subgenus *Chaetodon*, and not with the subgenera *Gonochaetodon* and *Megaprotodon*, which Weber and de Beaufort (1936) later recognized as genera. When compared with the three divisions of "Gruppe" rank into which Ahl split the subgenus *Chaetodon*, respectively with two, four, and three further subdivisions of "Sektion" rank, *falcifer* is excluded from group 1 by reason of the body form and from group 3 by having the median trunk scales little enlarged, with well-rounded margins and with the subhorizontal alignment retained; also in having more than 45 scale rows crossing the median line of the body. This leaves "Gruppe II," from sections D to F of which *falcifer* is excluded by the subhorizontal scale rows. From "Sektion C, *Chaetodon* s. str. = *Tetragonopterus* Bleeker," as briefly diagnosed by Ahl (p. 80), *falcifer* is not obviously excluded, but it has smaller scales than any of the species as counted by Ahl, except the very different "*Chaetodon Sanctae Helenae* Günther." In fact, the scales are rather too high for his generic diagnosis (p. 7): Ahl characterized the genus *Chaetodon* as having about 30 to 50 scales in "L. lat." (defined on p. 6 as the number "vom oberen Ansatz des Kiemendeckels" to the caudal flexure). Ahl thus contrasted *Chaetodon* with *Hemitaurichthys*, *Microcanthus*, and *Vinculum*, each of which was indicated as having 60 or more (60-90) scale rows. Those three genera all have the lateral line of the primitive *Heniochus* type, and one of them, *Microcanthus*, has been shown by Fraser-Brunner (1946) to have been wrongly classed in Chaetodontidae.

Chaetodon falcifer differs more trenchantly from any of the species placed by Ahl in his section *Chaetodon* in having a much longer, more produced, more pointed snout, in this respect definitely approaching *Forcipiger* and *Chelmon*. It agrees fully with none of the subdivisions of *Chaetodon*, including the segregated genera *Gonochaetodon*, *Megaprotodon*, and *Anisochaetodon*, as diagnosed by Weber and de Beaufort (1936). Further studies may call for its recognition as a member of a new subgenus, or possibly genus (presumably to include also the Atlantic species, discussed below).

Several characters that *Chaetodon falcifer* shares with *Heniochus nigrirostris* and *Forcipiger longirostris* (Broussonet), which is regarded as including *F. flavissimus* Jordan and McGregor, suggest the remote possibility of a relationship with one or both of those species; close enough, if verified, to run counter to the classification we have adopted.

Chaetodon falcifer agrees with *H. nigrirostris* in the size of the scales, in which respect *C. falcifer* contrasts with almost all species currently left in *Chaetodon*. It also agrees with that species, though not so exclusively, in the orientation of the scale rows. In the form of the spinous dorsal the

two species are similar, having strong and high spines with very deeply incised membranes; but in *C. falcifer* the third and fourth spines are subequal, whereas in *H. nigrirostris* the fourth spine is definitely the longest, as it is (to a greater degree) in the other species referred to *Heniochus* (furthermore, in the apparently closely related Atlantic species, *C. aya*, the third spine is definitely the highest). There are also some resemblances (as well as sharp differences) in the color pattern, for both species lack the suborbital bar characteristic of most species of *Chaetodon* and have the nuchal bar continued forward on the snout (though with interruptions in *H. nigrirostris*). The posterior dark crescent in *H. nigrirostris* suggests the posterior part of the scythelike mark of *C. falcifer*, though it is farther back and farther up.

Chaetodon falcifer approaches *Forcipiger longirostris* in the sharpness and production of the snout and in the reduced size of the scales. In both species the dorsal spines are high and the interspinal membranes are deeply incised. In both, the nuchal band is continued through the eye to and along the upper part of the snout. In some of these characters all three species under discussion show resemblances. At present, however, we interpret each of these resemblances as the result of convergent evolution. Numerous differences between all the forms may be noted by comparing the following description of *C. falcifer* with the descriptive notes of the three other Pacific species (pp. 295-300).

As already suggested (p. 00), *C. falcifer* seems to find its closest relatives in two Atlantic species, *C. aya* of the western Atlantic and *C. marcellae* of west Africa, which are treated in more detail on pages 300-304. The distinctive resemblances (compare figures) include the sharpness and production of the muzzle (a character that is carried to a farther extreme in *Prognathodes aculeatus* of the West Indian fauna); the very high, strong, and greatly excised dorsal and anal spines; the rather regular and little modified alignment of the scale rows; the rectangular form of the body behind the head; the more or less forward dislocation of the subocular bar (carried to an extreme in *C. falcifer*); a dark bar along the top of the head anteriorly; the presence and intensity of the blackish bar from eye to front of dorsal; the extension of the posterior bar to an abrupt end on the scale-covered base of the anal fin, etc. These resemblances seem to outweigh the sharp differences between *C. falcifer* and *C. aya* that are outlined in table 1, and that also apply largely to *C. marcellae*.

The close relationship between *C. falcifer*, *C. aya*, and *C. marcellae* is further suggested by their distinctively deep-water habitats. The type of *C. falcifer*, as indicated earlier, was collected at a depth of 100 feet. All specimens of *C. aya* and *C. marcellae*, so far as recorded, were taken at

even greater depths. The type of *C. aya* was from the stomach of a red snapper from Snapper Banks off Pensacola, Florida, where the depths fished at that time were reported by the collector, in his survey of the fisheries grounds (Stearns, 1887), to be 20 to 50 fathoms. Another specimen was trawled off North Carolina (Nichols and Firth, 1939: 87) at a reported position where the coast chart (1110) indicates the depth as approximately 150 fathoms (considerable error either in distance or direction would not fix the trawling spot at a depth of less than 100 fathoms)! Hildebrand (in Longley and Hildebrand, 1941: 150-151) reported the capture of seven specimens near Tortugas, Florida, at two stations, at depths of 39 and 40 fathoms, respectively, and added, "apparently not entering shallow shore waters." The additional known specimens of *C. aya* (see pp. 302-303) have been taken at depths recorded as 24, 25 to 30, 25 to 75, 37, 40 to 45, 62, and 75 fathoms.

DIAGNOSIS

Outstanding characters of *Chaetodon falcifer* are the very long and sharply produced snout, in which respect it definitely approaches *Forcipiger*; the rather small scales, intermediate in size between those on most species of *Chaetodon* and those typical of the species of *Heniochus* and related genera; the lack of a suborbital bar and the extension of the nuchal band, as in *Forcipiger*, through the eye to and along the snout; and the peculiar scythe-shaped blackish mark on the body. Less distinctive, but serving to separate the species from many others in *Chaetodon* (and segregated genera) are the dorsal and anal fin formulas, respectively XIII, 21 and III, 16; the high and strong dorsal and anal spines, with deeply incised membranes; the alignment of the scale rows, which are subhorizontal below the lateral line and parallel with that line above it; the rounded margins and only moderate enlargement of the median trunk scales; the rather rectangular body form; the low mouth; and the alignment of the inner jaw teeth anteriorly in twelve rather even cross rows.

DESCRIPTION OF FINS

DORSAL FIN. The dorsal rays number XIII, 21. The base of the spinous dorsal measures 1.6 in the soft-dorsal base. The dorsal spines are very strong and high anteriorly. The subequal third and fourth spines are the highest. Each, as measured from the edge of the scaly sheath, is as long as the soft-dorsal base. The interspinal membranes are deeply incised, very deeply anteriorly. The least width of the membrane at the front of the two longest spines is less than one-sixth the height of the spine. The soft dorsal has a

weakly rounded margin, with the median part nearly straight and forming an angle of 72° between its tangent and the axis of the body; the margin along the first three or four rays is nearly horizontal; that along the last few rays is rounded and is directed downward and slightly forward. None of the dorsal soft-rays are produced.

ANAL FIN. The rays number III, 16. The spines are very strong. The second is very notably strengthened and considerably elongated, though when depressed it just reaches the tip of the third spine. The free front edge of the second spine is as long as the base of the soft anal. The interspinal membranes are very deeply incised. The membrane at the front of the second spine is one-sixth the length of the front edge of that spine. The margin of the soft anal is nearly straight and nearly vertical medially, and is moderately curved forward along the anteriormost and posteriormost rays.

OTHER FINS. The caudal has a weakly convex border, with the upper angle rather pointed, though not produced, and the lower angle more broadly rounded. The very slightly falcate pectoral, which reaches to above the anus, is about one eye's length shorter than the head. The first pelvic soft-ray ends in a free filament, which is more than half as long as the orbit and reaches to between the genital papilla and the origin of the anal fin. The length of the pelvic equals that of snout plus orbit. Principal caudal rays, $9 + 8 = 17$; pectoral rays 15 on each side, or, more precisely, distinguishing unbranched and branched rays respectively on left and right sides, ii, 12, i—ii, 11, ii.

SCALES AND LATERAL LINE

SCALE NUMBER AND SIZE. The scales are relatively small and numerous. Along a straight line from the upper end of the gill opening to the caudal flexure we enumerate 51—53 transverse rows (counting both sides) behind the scapular process, and 4 rows on the process; there are 3 additional rows of scales, smooth and well embedded, on the concealed part of the shoulder girdle. Along the first row above the lateral line, beginning behind the scapular process and enumerating all scales that definitely impinge above on a lateral-line scale, we count 64—66 scales. From the edge of the scaly sheath beside the first spine, in an oblique row to but not including the lateral line, we count on each side 15 scales below the dorsal and 26 above the anal. There are about 30 rows, not including scales that overlap on the exposed field, around the narrowest part of the caudal peduncle. The scales become markedly reduced in size on the thick scaly area over the basal part of the soft-dorsal fin. The scales also become very small on the

nape, occiput, opercles, and muzzle. They are somewhat but not notably enlarged on the side of the trunk forward to the pectoral fins, but these larger scales grade evenly into the others.

SCALE FORM, SERIATION, AND DISPOSITION. The scales are regular in outline, with evenly rounded margins, even where moderately enlarged. Below the lateral line the scale rows are approximately horizontal, with a slight upward flexure posteriorly that increases to about 18° on the fleshy area over the anal base. Some rows are arched upward a little where the scales are most enlarged. Toward the pelvic fins the rows become irregular. Above the lateral line the rows are essentially parallel with this line and are similarly curved, on the body proper, but become irregular, and peripherally assume an oblique orientation, on the thick scaly fin bases, especially on the second dorsal.

Where, on and about the head, the scales become greatly reduced in size, the rows become very irregular or hardly apparent. Very small rough scales are developed on the posterior part of the premaxillary, especially in files along the fine rugose ridges. A narrow band of etenoid scales crosses the top of the premaxillaries just in front of the rostral groove (this character will likely prove variable, as it is in *C. aya*). The exposed part of the maxillary, behind the anterior grooved area, is evenly covered with small etenoid scales. Fine etenoid scales cover the mandibles forward to a little beyond the end of the gape. There is only a small scaleless area around the anterior nostril and below the posterior nostril. This scaleless strip extends backward to the orbit below the anterior prolongation of the upper bony orbital rim. A very narrow and irregular scaleless groove, seemingly distinctive among the American Pacific species of the subfamily, but which will probably prove variable, as it is in *C. aya*, extends forward from in front of the anterior nostril to the row of scales bordering the rostral edge. A small triangular scaleless area (which will probably prove variable, as it is in other species) extends upward and backward from the upper bony orbital rim. At the apex, the width of this scaleless area is only about one-fifth that of the orbit. The fleshy upper orbital rim, largely concealed by the bony rim, bears some scales, mostly small and smooth (probably also a variable character, or one affected by loss of scales).

The scaleless margin of the soft dorsal is about one-third as wide as the orbit; that of the soft anal, about one-fourth the orbit. In each fin the outer part of the interradiial membranes is more or less scaleless for an additional distance about equal to the width of the totally scaleless margin. Anteriorly, these scaleless grooves are more extensive. Along the thickened base of each alternate dorsal spine and along one side of the third anal spine an acute triangle of scales runs well out on the spine. Except on a basal band about two-thirds as wide as the orbit, and near the upper and

lower margins, the caudal fin is very weakly scaled. The scales on the branching rays are very small, delicate, and difficult to see. Beyond the scaly base single or double files of scales extend only a very short distance outward on each interradiial membrane, scarcely at all on the membranes between the innermost rays. (It is possible that etenoid scales may have covered more of the caudal in life.)

LATERAL LINE. The lateral line forms an almost even arc backward to its end about five tiny scale rows before and above the end of the dorsal base. The pores behind the scapular process number 44-46. The small lateral-line scales are more isolated from one another than in *C. aya*. On the midsides in advance of the vertical from the end of the lateral line, on the right side only, are two pored scales in series (not included in the count).

BODY AND HEAD CHARACTERS

BODY FORM. Behind the head, the body, including the fleshy scaled fin bases, is virtually square. The vertical depth from the edge of the dorsal scale sheath to near the pelvic insertion steps 1.75 in the standard length. The edge of the thick scaly covering of the dorsal fin is approximately straight and horizontal from the second dorsal spine to the extreme front part of the soft dorsal. The ventral contour is similarly almost straight and horizontal from a little in front of the pelvic insertion to the extreme anterior part of the soft anal. From the dorsal origin to the concavity of the snout the profile is almost straight (very slightly sigmoid) and forms an angle of 52° with the body axis and an angle of 83° with the chord of the anteroventral contour behind the muzzle. The scaly bases of the soft-dorsal and soft-anal fins appear very steep in external view, though the actual structural bases as measured on the X-ray photograph (plate I, figure 2) describe an angle of only 81° .

SNOUT AND MUZZLE. The snout is notably produced, narrowed, and sharpened. Its dorsal profile forms an angle of 150° with the profile between the snout and the dorsal fin. The angle of the muzzle is about 40° in lateral view and 29° in dorsal aspect (each measurement excluding the abruptly rounded tip.) The greatest width in front of the eye steps 1.8 in the length of the snout. Since the snout is a little longer than the postorbital, the center of the eye is slightly behind the middle of the length of the head, which, including the opercular membrane, steps 2.8 in the standard length.

MOUTH AND JAWS. The front of the low and subhorizontal gape lies definitely below the lower border of the orbit. The lower border of the upper jaw forms an angle of 21° with the body axis. The gape is not quite half the length of the upper jaw, which enters the head length 3.5 times. The anterior parts of the jaws are expanded forward to accentuate the beaklike form of the snout. The midline length of the upper lip is actually

more than half the length of the orbit. Above and behind a deep fissure the lips are sculptured by parallel grooves and more or less crenate ridges. The fissure is about three-fourths as long as the orbit. It starts, in side view, near the middle of the anterior premaxillary expansion and extends to approximately the middle of the length of the posterior maxillary dilation, near its lower border. There is no vertical groove on the maxillary. The margin of the upper lip is somewhat pendant, especially on the sides opposite a slight anterior lobation of the lower lip. The front of the gape is narrowly and evenly rounded transversely, with no marked irregularity on either lip.

TEETH. The teeth of the jaws extend to the end of the gape. Those of the outer row are slightly enlarged. The very fine inner teeth are definitely aligned in each jaw in twelve nearly straight transverse rows across the semispherical tip of the beak. Posteriorly the inner teeth are less regularly arranged and form a narrower band. The midline length of each anterior tooth patch measures 3.5 in the orbit. The vomer is edentulous.

GILL RAKERS. The rakers, including rudiments, number $5 + 11$ on the outer arch. Those of the upper limb are soft. The longest, near the middle of the lower limb, barely reach the second raker below.

BONY MARGINS. The preorbital border is finely denticulate, especially at the squarish anterolateral corner. The preopercular denticulations, mostly very fine, are somewhat enlarged and directed backward at the rounded angle, above which the nearly vertical margin is rather strongly concave and below which the somewhat oblique edge is weakly concave. The exposed border of the scapular process is also denticulate.

The upper border of the orbit is roughened by several series of minute denticulations. In the scaleless area, extending upward and backward from the upper orbital rim, the fine spinulation continues for a short distance and then becomes transformed into larger points and very short ridges, rendering the whole exposed area rough (perhaps more so than in other specimens). The bony orbital rim is scarcely expanded in the prefrontal region. It is extended downward and forward about halfway to the posterior nostril, departing here from the margin of the orbit and lying above the scaleless area behind the nostrils (this character will probably vary widely, as it does in other species). The bony orbital margin is extended down the posterior edge, to continue below the orbit and up to near the middle of the front edge. Around the lower half of the orbit the more or less trenchant bony rim is armed in the type specimen with a row of fine serrulations, in places backed by other, minute points.

OSTEOLOGICAL FEATURES

VERTEBRAE AND HYPURALS. Many of the bony structures can be made

out on an X-ray photograph (plate I, figure 2). The vertebrae number 10 + 14 (including the hypural plate). The first two are reduced in size. The caudal rays impinge on eleven hypural elements, six above and five below, of which 3 + 3 comprise the hypurals proper, arising from the lower edge of the upturned axis. The hypurals support all seventeen principal caudal rays except the lowermost two, which arise, respectively, just above and on the more posterior of the two hypural-like interhemals of the twenty-third vertebra. On the six hypurals the principal rays originate according to the following formula, counting downward: $3 + 4 + 2 = 9$; $1 + 4 + 1 = 6$. The four upper procurrent rays arise from the two loose epurals, and a minute blob of ray tissue lies beyond the tip of the neural element of the last vertebra. The three lower procurrent rays arise from the two hemal elements connected with the last normal centrum. Only the posteriormost procurrent ray, above and below, is segmented.

VERTEBRAL SPINES AND INTERSPINALS. The interneurals of the last two dorsal spines arise on either side of the definitely longer neural spine of the twelfth vertebra. This neural spine is sagittally expanded toward the base, thus contrasting with the spines that follow. From the twelfth to the eighth the neural spines remain nearly at right angles to the vertebral column, increase in thickness, and become shorter, finally to reach only halfway to the base of the dorsal spines. From the seventh to the third the neural spines become oblique and still shorter. The first two become more erect and the first is the smallest. The interneurals increase in strength forward from that of the last dorsal spine to that of the second spine, which interneural is directed slightly forward to fit between the first two neural spines close to the vertebrae. The interneural of the first dorsal spine comprises a flat shaft that impinges on the following interneural and that bears, at its upper end, a strong thornlike process directed forward and downward. The two rodlike interneurals that arise on either side of the tip of the first neural spine have, at the top, nearly fused, forward-directed, thornlike processes, which, together with the larger process just mentioned, form a bridge, hidden beneath the sharp anterodorsal rim of the body, between the first dorsal spine and the very strong, high, and sharply elevated supraoccipital spine. The hemal spine of the first caudal vertebra is considerably expanded where it lies behind the very strong spinelike interhemal of the second anal spine. That interhemal reaches slightly more than halfway to the central line of the vertebral column.

SKULL. Above the orbital rim and the base of the first vertebra, the skull in side view forms approximately an equilateral triangle, with the apex, at the base of the supraoccipital spine, located above the isthmus a distance equal to that from the tip of the snout to the posterior margin of

the shoulder girdle. In side view the premaxillaries and dentaries are very slender. The least dorsoventral dimension of the premaxillaries, near the rear of the anterior dental expansion, is only 0.1 the antorbital length of the skull.

COLORATION

(Plate I, figure 1)

SCYTHE-SHAPED MARK. The outstanding colorational feature of this species is the scythelike mark on the sides of the head and body. In life this mark was deep brown-purple, almost jet-black. After over a year in 40% isopropyl alcohol, following initial preservation in formalin, this color, like many of the others, is little changed. The short "handle" of the "scythe" begins abruptly at the upper-posterior part of the interopercle, beneath and behind the preopercular angle. The "handle" continues upward and slightly backward to cover the subopercles and the opercle behind the upper bony process. There are dusky dapplings on the adjoining branchiostegal membrane. Continuing its steep course, at an angle of 62° with the axis of the body, the mark crosses the opercular membrane and attains a position astride the lateral line. Along the middle third of its anterior section, where it is slightly arched backward, the mark is about as wide as the orbit. The front edge of the band is weakly arched forward dorsally and extends to a rounded angle, somewhat greater than a right angle. The angle of the axis is about 80° . The apex is separated from the edge of the scaly sheath near the front of the fifth dorsal spine by an interval about two-thirds as wide as the orbit. The lower-posterior border of the anterior section of the mark follows throughout most of its length a nearly straight course, a little steeper than the anterodorsal contour of the body. Dorsally the ventral border arches rather abruptly backward, to reach its apex below the posterior exposed base of the fifth dorsal spine, in the third scale row below the lateral line. From the apex the lower border is gently curved to the acute end of the "scythe" on the sixth anal soft-ray. The upper border continues backward and slightly downward, nearly straight, to descend below the lateral line at a point nearly in line with the last spine of the normally expanded dorsal fin; that is, at a point about midway between the apex of the mark and the end of the dorsal base. From this point the upper edge of the "scythe" arches backward and then downward to the lower-posterior end. On the fleshy base of the anal fin the posterior edge of the mark is nearly straight and nearly vertical. The mark is separated from the end of the dorsal base by a distance two-thirds the length of the orbit; from the caudal flexure, by one orbital length; and from the end of

the anal base, by about one-fourth the orbit. The width of the band, measured either downward and backward from the anterior apex, or at the greatest width posteriorly, steps 2.4 in the head length. The least width between those points, not far behind the apex, is 3.3 in the head.

BAND THROUGH EYE, AND ADJACENT COLOR. Another prominent and conspicuous mark is the band, rather rich-brown in life and sooty blackish in preservative, that extends from the base of the first two or three dorsal spines downward and slightly forward to the upper rim of the orbit. With decreased intensity, though still conspicuous, it cuts obliquely across the eye and then continues, much less steeply and with a weak downward curvature, well above the mouth, toward but not quite to the rostral fold; except near the eye, the lower border is horizontal. The narrow light area in front of the band was somewhat yellow in life. Above and behind the eye there was considerable yellow both before and behind the band. On the head above the eye the mark is blackest, with a further intensification along either edge. Farther upward and backward the anterior edge remains sharp, along the narrow light V on the predorsal contour. Posteriorly, the upper part of the band fades gradually into a pale color, with (in preservative at least) silvery specks at the scale bases. These specks extend to the "scythe." The greatest width of the stripe, where well defined, is about three-fourths that of the orbit.

MIDDORSAL STRIPE ON HEAD. A third stripe, about one-third as wide as the orbit, dusky-centered and blackish-edged, extends from above the middle of the eye to the premaxillary groove. It is continued forward, on the top of the broad premaxillary expansion, as a solid blackish bar about one-fourth to one-sixth as wide as the orbit.

SIDE OF HEAD. In advance of the "scythe" the sides of the head in life reflected rather strong blue glints, which were strongest on the opercles. The very edge of the orbit, posteriorly and ventrally, is light (bright yellow in life). Since the ocular bar is extended forward on the side of the snout there is no trace of a suborbital bar, and since the anterior part of the "scythe," representing the second bar of many species, extends across the opercles, there are no markings about the pectoral base. In the field notes no evidence was recorded of definite light margins on the main dark bars, such as are evident on specimens of *C. aya* preserved in alcohol.

ABOVE AND BEHIND THE "SCYTHE." Above and behind the "scythe," down to the level of the upper edge of the caudal peduncle, and extending over the thickened scaly base of the dorsal fin, the color in life was purplish-gray over a yellowish base. The purplish-gray remains in the alcohol-preserved specimen. In this area there are faint dusky specks at the scale bases. Where it is exposed along the upper edge of and behind the "scythe,"

the lateral line in life was iridescent silvery on the specialized scales, and in alcohol the line remains light. In life the caudal peduncle was yellow-brown, becoming almost clear yellow ventrally. In alcohol the peduncle is lightened, especially on the lower surface.

BELOW THE "SCYTHE." Below the black mark the sides were brightened in life by silvery-violet reflections. In this area there were rather indistinct purplish-gray streaks along the middle of the scale rows. Anteriorly, this color became almost solid on the scales, except for a creamy anterior border. The purplish-gray streaks remain in alcohol, and silvery flecks are generally interspersed between the streaks.

VENTRAL SURFACE AND LOWER FINS. In life the ventral surface was lemon. This color extended onto the pelvic and anal fins and became intensified on the membranes behind the spines. Otherwise these fins were dusky olive-yellow, shading outward to blackish-brown at the margin of the pelvic soft-rays (excluding the pale filament) and just within the margin of the soft part of the anal fin. In alcohol the anal spines are pale gray, but the soft anal becomes almost solid black on the sharp outer edge of the dark area. The clear margin becomes pinched out at the first anal soft-ray. Along the upper, posterior part of the fin the abruptly clear margin is about one-sixth as wide as the orbit. The pelvic in alcohol remains blackish toward the posterior margin, leaving the spine, the front of the first soft-ray, and the filament pale gray. The pectoral was essentially clear in life. In alcohol its upper margin is slightly darkened and the rays are set off by fine purplish edges.

CAUDAL FIN. In life this fin had some purplish-gray on the rays. In alcohol the fin is slightly dusky, with a blackish upper and lower border, and there are blackish edges along the rays near the middle third of their length.

DORSAL FIN. In life the spines of this fin were purple-black and the median interspinal membranes were blotched with yellow and purplish-gray. The outer part of the fin from the seventh spine backward was sooty with some purple, and with some yellow showing through. The soft dorsal was purplish-gray over pale yellow basally, then light yellowish in an irregular, subvertical band, which was followed by a blackish-purple band inside the almost clear, slightly purple-gray margin. In alcohol the blackish color remains. It is more or less solid on the exposed parts of the spines, except for a lighter basal streak from the third to the tenth spines. The first two membranes are almost solidly blackish. The third to sixth membranes are light, with blackish dappling. Except on the pale basal streak the following membranes, where exposed, are blackish, especially behind the spines. The blackish area on the outer-posterior part of the spinous dorsal is con-

tinued backward, and then downward on the soft dorsal, as a submarginal blackish band, which becomes narrower and intensified toward the end of the fin. On the anterior third of the soft dorsal the band is about as wide as the orbit and fades into the purplish base of the fin, but on the posterior two-thirds of the fin the blackish and purplish areas are separated by the remnants of the subvertical yellowish band. Throughout the fin the dark streak is abruptly separated from the margin by the clear light area, which, except toward the ends, is about one-third as wide as the orbit. Thus, the soft dorsal and the soft anal are very similarly colored.

MEASUREMENTS

PROPORTIONS OF PARTS COMPUTED AS THOUSANDTHS OF THE STANDARD LENGTH (138 mm.). Greatest body depth (from near pelvic insertion vertically to top of scaly sheath), 554; least depth of caudal peduncle, 104; length of peduncle from end of anal base to caudal flexure on midline, 86. Predorsal length, 425; prepelvic length, 433; caudal flexure to anal origin, 397; thence to pelvic insertion, 317; thence to isthmus, 223. Length of head to edge of opercular membrane, 354. Widths of head: at widest point, 130; at muzzle, across front of orbits, 81; across maxillaries, 70; opposite front of rostral groove, 45. Length of upper jaw, 103; midline length of upper lip, 46. From anterior nostril to rostral groove, 69. Length of orbit (between free rims), 79. Least distance from free rim of orbit: to front of upper lip (length of snout), 147; to rostral fold (preorbital width), 97; to suborbital margin, behind mouth (suborbital width), 70; to other orbit (least fleshy interorbital width, anteriorly), 75; to farthest point on margin of opercular membrane (postorbital), 141; to preopercular angle, 119; to ventral contour of head, 109; to dorsal origin, 246. Length of dorsal spines (along middle of side above edge of scaly sheath, disregarding scaly extensions along front of alternate spines): first, 96; second, 178; third and fourth, 280 each; fifth, 246; sixth, 225; seventh, 193; eighth, 168; ninth, 137; tenth, 120; eleventh, 100; twelfth, 85; thirteenth, 67. Length of anal spines, similarly measured from scaly sheath: first, 93; second, 198; third, 165. Other fin measurements: length of anal base, 310; length of middle caudal rays, 180; length of pectoral from upper axil, 266; width across pectoral base, 81; length of pelvic spine along front, 226; length of pelvic fin, including filament, 293.

DERIVATION OF NAME

The species name *falcifer* is the Latin word signifying scythe-bearer, in allusion to the diagnostic scythe-shaped color mark. We treat it as a noun and it is therefore not declinable.

DISTINCTIVE CHARACTERS AND RELATIONSHIPS OF THE
THREE OTHER EASTERN PACIFIC CHAETODONTINES

An examination of the three other chaetodontines of the eastern Pacific, made in the University of California at Los Angeles by courtesy of Boyd W. Walker, has disclosed a considerable number of distinctive characters in the structure of the head and in the squamation of the head and caudal fin. Sharp differences between all four species are apparent in most of these characters. Some of these specific differences may well prove useful in the definition of species groups and subgenera, perhaps even of genera. Since we have no present opportunity to test the wider application of these features in the classification of the group, we offer only the following descriptive remarks, accompanied by inferences as to the relationships of the three species.

Chaetodon humeralis Günther.

The series of specimens (W 51-20) studied in most detail was taken by Boyd W. Walker and party on January 25, 1951, on the shoreward side of Isla Venado, near Mazatlán, Sinaloa, México, but others were examined to verify the consistency of the characters.

MOUTH AND GAPE. As seen from above, the mouth is rather evenly arched and shows only a trace of lateral knobs.

LIPS. The upper lip is divided laterally by a prominent lengthwise groove, behind which the skin is broken into rather fine but sharp folds and creases. The main lengthwise groove is continued backward and downward as a deep fissure, behind which the surface is scaly and before which it is smooth, except for an irregular subvertical groove seen only in this species.

TEETH IN JAWS. In each jaw there are about 8 cross rows of fine teeth behind the somewhat enlarged outer row. In the lower jaw the rows are broadly curved.

BONY MARGINS. The preopercle and the lower preorbital margin are finely denticulate. The bony orbital rim is weakly denticulate at the very edge only. There is no rough exposed bony area above the orbit.

SQUAMATION ABOUT ORBIT AND MUZZLE. There is no scaleless area above the orbit. In fact, the narrow fleshy band along the upper part of the orbit is fully exposed and is closely covered with hard etenoid scales. These scales expand the flattish interorbital area a little on each side. The scaleless fossa about the nostrils is very small. The snout is well sealed forward to the rostral groove except for a small area on each side about a slight knob

at the front of each preorbital. The lower edge of the preorbital is nearly concealed by scales. The posterior exposed lobe of the maxillary is covered with strongly etenoid scales.

SQUAMATION OF CAUDAL FIN. The caudal is covered by etenoid scales over more than three-fourths of its length, leaving a naked margin somewhat wider than that on the soft parts of the dorsal and anal. The basal band of body-type scales is broader than in the other species. The small though rough scales are in strips centered along the interradiial membranes, but these strips contain several scale rows, and they are so wide that there intervenes between each pair only a narrow, more or less closed groove along the unbranched part of each ray out beyond the thickly scaled basal area of the fin.

RELATIONSHIPS. This, the only previously described species from the eastern Pacific to be retained in *Chaetodon*, seems fully distinct from its nearest congeners in the Indo-Pacific and West Indian faunas. No attempt has been made to seek its nearest apparent relatives.

Heniochus nigrirostris (Gill).

The specimen (W 52-258) examined in most detail was collected in Bahía San Lucas, Baja California, by Murray A. Newman and John E. Fitch, on December 1, 1952. Other examples were checked to verify the characters.

MOUTH AND GAPE. The front of the gape is almost straight and transverse, with an almost lobular angle on either side of each jaw.

LIPS. In this species the lips are only weakly grooved in advance of, and above, about three moderate oblique fissures in the premaxillary region. There is no main longitudinal groove and no vertical groove on the maxillary, the exposed face of which is moderately rugose.

TEETH IN JAWS. The inner teeth are in only about 6 transverse rows in the front part of each jaw. In the lower jaw the arrangement is less regular than in the upper jaw and the rows are less transverse, because of the close approximation of the mandibles.

BONY MARGINS. The preopercle and the lower margin of the preorbital vary from nearly smooth to finely and regularly denticulate. The lower border of the orbit is finely denticulate with tiny uniserial teeth. On the upper orbital border the bony points are more numerous and are pluriserial. This rough and exposed bony margin continues into a triangular expansion above and inward from the middle of the orbit. On the nearly naked, slightly fleshy area on each side of the interorbital, inward from and in front

of the rugose area, there is evident a branching pattern of lateral-line canals. In the prefrontal region, the upper orbital margin is produced as a slight flange, with somewhat strengthened denticulations.

SQUAMATION ABOUT ORBIT AND MUZZLE. The fleshy upper orbital rim is scaleless in this species. Under the prefrontal flange just mentioned this dermal band bears several finely papillate dermal ridges. The rugose bony area within and above the bony orbital rim is nearly all scaleless, as is a fleshy area in advance thereof. The scales on the top of the head become obsolete between the nostrils, with few extending slightly farther forward. There is a wide, almost wholly scaleless fossa about the nostrils, continuous with the naked front of the muzzle. There appear to be no scales on the maxillary.

SQUAMATION OF CAUDAL FIN. The body-type scales form a rather narrow basal band on the caudal, with extensions toward the upper and lower margins of the fin. Over most of the rest of the fin the scales (bearing moderate etenii) extend much less than halfway to the rear margin; they are in single series overlying the subbasal part of the interradiial membranes, leaving the intervening rays largely free of scales.

GENERIC POSITION. As can be seen from the figures of *nigrirostris* published by Jordan and Evermann (1900: 3283, pl. 248, fig. 620), by Gilbert and Starks (1904: 148-149, pl. 24, fig. 47), and by Schultz (1951: 486, fig. 94), and as can be determined from Hildebrand's key and descriptions (Meek and Hildebrand, 1928: 766-770), *nigrirostris* differs sharply from other species referred to *Chaetodon* (including *C. falcifer*) in having the lateral line extended to the middle of the base of the caudal fin, instead of ending at the axil of the soft dorsal fin or at some point high on the fish anterior to and approximately in line with the axil. This distinction in posterior termination and position of the lateral line was used by Herre and Montalban (1927: 13-14), justifiably we think, as a primary character in the generic analysis of the family. Weber and de Beaufort (1936: 15-16) also utilized the character in their generic analysis of the Chaetodontinae (but, in this respect, inadvertently misplaced *Heniochus* in their key). The same or similar lateral-line characters have been employed in recent analyses of the genera of the subfamily Pomacanthinae (Fraser-Brunner, 1933; Smith, 1955).

For these reasons we think that *nigrirostris* is misplaced in the genus *Chaetodon*. It does not, however, fit perfectly into any of the genera as defined by Herre and Montalban, or by such other revisers as Günther (1860: 2), Bleeker (1878: 22-72, and preceding papers), Jordan and Evermann (1898: 1673; 1905: 362), Ahl (1927: 7), Weber and de Beaufort (1936: 14-16), and Woods (in Schultz, 1953: 566-575).

The species *nigrirostris* would fit into *Heniochus* quite well if the fourth dorsal spine were more produced or if the orbital or nuchal spines were developed (the apparent predorsal spine in Schultz's 1951 figure 94 is a printer's artifact, as can be seen by checking this figure with another, from the same drawing, published by Jordan and Evermann). But since *Heniochus* is characterized either by having the fourth dorsal spine more or less prolonged or by having hornlike processes on either the orbit or the nape, or both, *nigrirostris* may be interpreted as having been derived from the common ancestor of this assemblage, as thus heterogeneously diagnosed, for it, as the inferred ancestor presumably did, lacks the specialized processes and has the fourth dorsal spine only slightly produced (less so than in any species currently referred to *Heniochus*). Pending further studies, we suggest that *nigrirostris* be referred to *Heniochus*, and thus be named *Heniochus nigrirostris* (Gill). It might also be referred to *Hemitaurichthys*, though it differs from the species of that genus, as currently distinguished (as by Weber and de Beaufort, 1936: 15, 24-25), in having the fourth dorsal spine rather than the middle ones highest, the scales less reduced in size, and the body outline less elliptical. These are relatively minor characters. Until more trenchant differences are encountered, some doubt will pertain to the separation of *Hemitaurichthys* from *Heniochus*.

We feel considerable reserve in the reference of *nigrirostris* to *Heniochus*, because the current classification of the chaetodontines is so unsatisfactory. Furthermore, Loren P. Woods, who has studied the family extensively, has suggested (in letter) that the contrasting lateral-line characters on which we have relied may tend to intergrade. But on checking his notes on this character, for 39 species that he placed in *Chaetodon*, it appears that he found the lateral line proper incomplete and ending far above the axis of the body in all, with the tubes ending at some point under the posterior half of the soft dorsal (or, under the middle part of the second dorsal in *C. triangulum*, which is referred to *Gonochactodon* by Weber and de Beaufort, and in *C. auriga*). In two species he found, in addition, some lateral-line structures in a separate series on the midside of the caudal peduncle (as is also true of some pomacanthines). In *C. auriga* Forskål he observed a few "pored scales" but no tubes on the peduncle, and in *C. miliaris* Quoy and Gaimard he located on the peduncle a double row of pitted scales. In the same two species we find only some neuromast pits (in part short-linear in *C. miliaris*) in the axial scale row on the peduncle and on a few scales running upward and forward, but not nearly connecting with the lateral line proper. We have found similar neuromast pits in some specimens of *C. aya*, which may also have other pits on the first scale row above the lateral line and, scatteringly, elsewhere on the body. The type of *C. falcifer* has, on the right side only, two misplaced tubes and pores on the midside

before the vertical from the end of the lateral line. We do not regard such irregularities as of any great taxonomic significance.

Furthermore, Leonard P. Schultz, after examining for us a long range of species in the United States National Museum, concurs in our interpretation of the generic significance of the lateral-line character and in the provisional reference of *nigrirostris* to *Heniochus*. Examination of many published figures seems to confirm the significance of the lateral-line distinction. Certain apparent exceptions to the lateral-line character appearing on the plates in Bleeker's "Atlas" (1878) become resolved when it is seen that the names and figures were inadvertently transposed on plate 375 for *Coradion melanopus* and *Megaprotodon strigangulus* and on plate 376 for *Tetragonopterus (Linophora) Rafflesii* and *Coradion chrysozonus*.

Forcipiger longirostris (Broussonet).

The specimens studied were one (W 55-161) taken at Isla Clarion of the Revillagigedo group by Richard H. Rosenblatt and Raymond M. Gilmore on May 7, 1955, and two (W 53-351) from Isla Socorro, of the same group, taken by Bayard H. Brattstrom on November 18, 1953.

MOUTH AND GAPE. The very peculiar mouth of this species has been duly described. In top view it is very narrow and rounded.

LIPS. There are no prominent grooves or ridges on either the premaxillary or the maxillary region.

TEETH AND JAWS. The inner teeth in the front part of the beak are arranged in about 20 to 25 cross rows in the upper jaw and in 25 or more rows in the lower jaw.

BONY MARGINS. The preopercular edge varies from strictly entire to incipiently denticulate. The lower border of the preorbital is smooth anteriorly, slightly to moderately denticulate posteriorly. The lower border of the suborbitals is either free (with smooth edge) or bound down. The upper and lower anterior corners of the preorbital are produced in bony lobes. When and where naked, the surface of the preorbital is more or less strongly sculptured, somewhat like the skull above each orbit. In that region, to a varying degree, the skull bones are exposed in a crescentic area, with definite bony ridges in a very complicated pattern, largely lengthwise anteriorly and dorsally, largely scroll-like posteriorly and ventrally. The actual bony rim is rough but hardly denticulate.

SQUAMATION ABOUT ORBIT AND MUZZLE. The scaleless area above the orbital rim varies considerably, but near the rim is probably always naked. On the preorbital the scales may be cycloid and confined to an anterodorsal patch, or may be etenoid over almost the whole bone. There is a large

scaleless narial fossa and most of the top of the snout anterior to the nostrils is naked; but here also the completeness of the squamation varies. The top of the beak just before the rostral fold may be either naked, like the rest of the beak, or may bear a variable patch of smooth scales. The narrow fleshy band along the upper orbital rim is scaleless, and in some specimens is concealed beneath the bony rim.

SQUAMATION OF CAUDAL FIN. The squamation of the tail fin is essentially as in *H. nigrirostris*, with a narrow basal band of ordinary overlapping scales and irregular uniserial rows extending out on the membranes, but ending short of the middle of the rays over most of the fin.

RELATIONSHIPS. It seems highly probable that *Forcipiger* was derived from a *Heniochus*-like ancestor with a primitive lateral line. Its chief modification seems to be the beaklike muzzle, which is presumably an adaptation for the procurement of food in small recesses, on the coral reefs that are spectacularly overgrazed. The interpretation of *Prognathodes* as convergent in the beaklike structure (see following section) lessens the apparent taxonomic value of the character and discounts any probable direct relationship between *Forcipiger* and such species of *Chaetodon* as *C. falcifer* and *C. aya*.

TAXONOMIC NOTES ON ATLANTIC RELATIVES OF *CHAETODON FALCIFER*

Following are the synonymies, records, and taxonomic notes for the three little-known Atlantic species that we regard as rather close relatives of *Chaetodon falcifer*.

Chaetodon aya Jordan.

(Plate II, figure 1; Plate III, figure 1.)

Chaetodon aya JORDAN, 1886: 225 (original description; distinguished by coloration; Snapper Banks, near Pensacola, Florida). EIGENMANN and HORNING, 1887: 5, 8, 18 (comparison and diagnosis, based on type; northern Gulf Coast of Florida; Pensacola). JORDAN and EVERMANN, 1898: 1673, 1676-1677 (comparisons; description; rather deep water; Gulf of Mexico). AHL, 1923: 122-123 (after Jordan and Evermann; placed in section *Chaetodontops*, misspelled *Chaetodontops* on p. 111). BREDER, 1929: 215, 217 (comparisons; Gulf of Mexico; chiefly in rather deep water; "may represent the young of some other species").

PLATE II

Figure 1. *Chaetodon aya* Jordan, from half-grown specimen (C.N.H.M. 45564) 65 mm. long, trawled off northern Florida at a depth of 25-30 fathoms. The dark margins on the soft dorsal and anal fins and the dark bar on the caudal are photographic artifacts. Photo by Scripps Institution.

Figure 2. Holotype of *Chaetodon marcellae* Poll, reproduced, by permission, from Poll (1950: fig. 1).

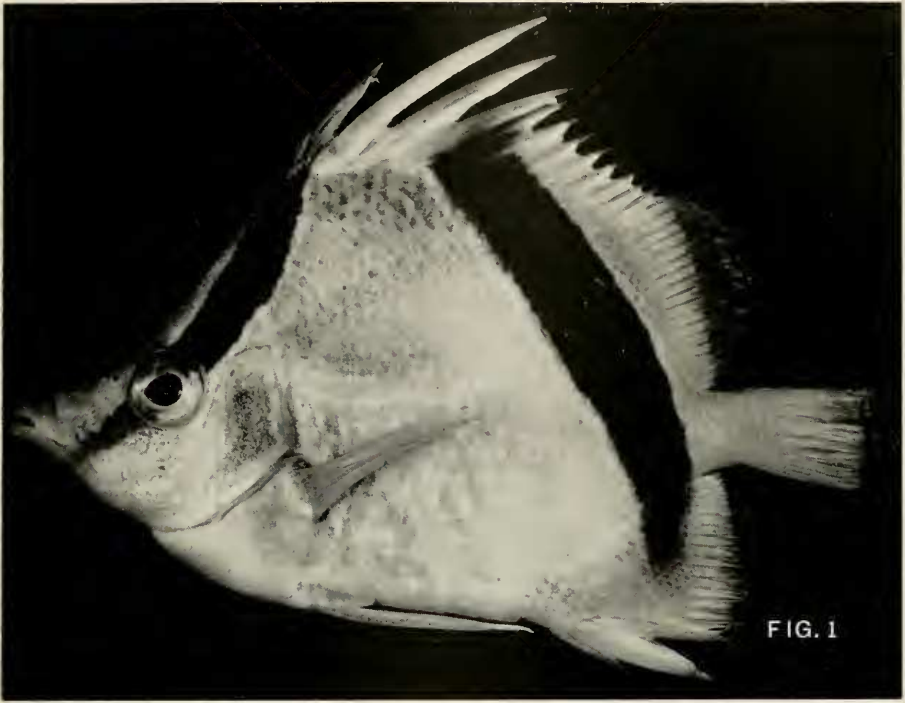


FIG. 1

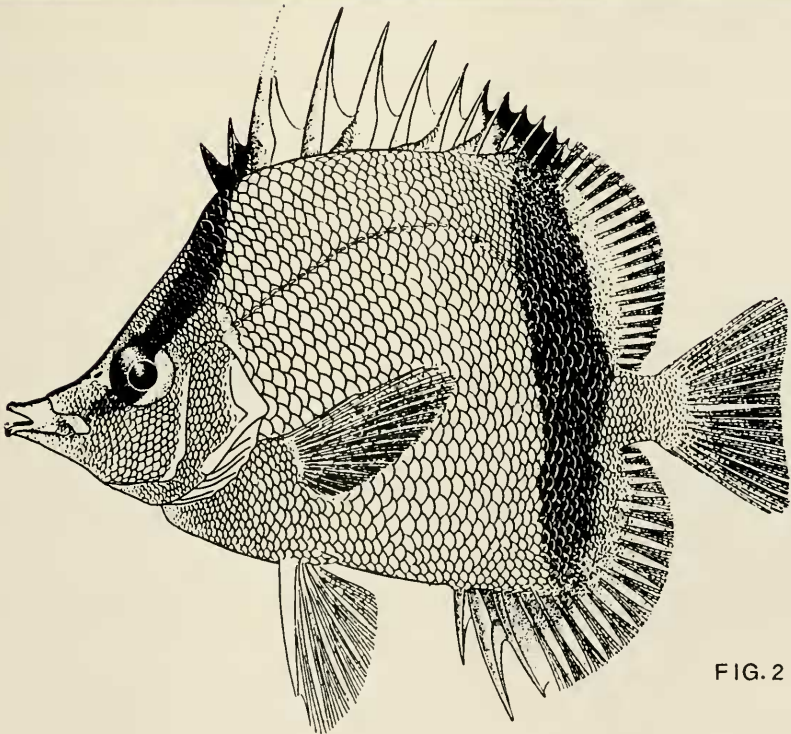


FIG. 2

NICHOLS and FIRTH, 1939: 87-88 (off North Carolina; faunal relationships; description). HILDEBRAND, in LONGLEY and HILDEBRAND, 1941: 150-151 (Tortugas, Florida; depth distribution; color; counts and proportions; except smallest specimen, which is *C. ocellatus*).

Increased collecting in deeper water has yielded a moderate amount of material of this species, which was long known only from the holotype. Following are data on the material in the United States National Museum and the Chicago Natural History Museum. No specimens were located in the Museum of Comparative Zoology, in the Academy of Natural Sciences of Philadelphia, or in the University of Michigan Museum of Zoology. The only other specimen known is the one reported by Nichols and Firth.

U.S.N.M. 37747 (1 half-grown, 28.7 mm. in standard length, slightly over 1¼ inches to end of broken caudal): near Pensacola, Florida, Silas Stearns.—This is obviously the holotype.

U.S.N.M. 37862 (1 subadult, 63 mm. long): "W. Coast of Florida, Str. *Albatross*, 1885."—This specimen has not been mentioned in the literature. It is much too large to be the holotype.

U.S.N.M. 116850 (7 specimens, half-grown to adult, 32-82 mm.): south of Tortugas, Florida.—These are the specimens collected by William H. Longley and reported by Hildebrand (in Longley and Hildebrand, 1941: 150) as having been taken at two stations: the two largest, 70-82 mm. long, now tied together with tin tag number 12, from 39 fathoms; the five smallest, 32-69 mm. long, from 40 fathoms. These series correspond with Longley's total-length measurements of 90-102 and 41-85 mm., respectively. The eighth specimen, 27 mm. in total length, 22 mm. to caudal, which Hildebrand reported as obviously representing a third collection of the species, for which no data could be found in Longley's notes, proves to be a typical young example of *Chaetodon ocellatus*. It has been recataloged as U.S.N.M. 164519.

U.S.N.M. 131893 (1 adult, 81 mm. long): Gulf of Mexico, at *Albatross* Sta. 2365, just north of the tip of Yucatán Peninsula, at 22° 18' 00" N. Lat., 87° 04' 00" W. Long., depth 24 fathoms, bottom of white rock and coral, January 30, 1885.

U.S.N.M. 151980 (1 adult, 98.5 mm. long): Long Bay, South Carolina, trawled by the *Albatross III* on cruise 31-C, Sta. 3, tow 5 (No. 14593), from 33° 35.5' N. Lat., 76° 53.5' W. Long., to 33° 36' N., 76° 51' W., depth 40-45 fathoms, February 10, 1950.—This specimen is shown on plate III, figure 1.

U.S.N.M. 152023 (1 adult, 82 mm. long): off Carolina Beach, North Carolina, trawled by the *Albatross III* on cruise 31-A, Sta. 2, tow 2 (No. 14506), from 34° 05' N. Lat., 76° 21' W. Long., to 34° 01' N., 76° 18' W., depth 25-75 fathoms, January 19, 1950.

C.N.H.M. 45564 (2 subadults, 63-65 mm. long): Gulf of Mexico, off northern Florida, trawled by the *Oregon* at Sta. 727-728, 28° 44' N. Lat., 85° 01' W. Long., depth 25-30 fathoms, December 16, 1952.—One of these specimens is shown on plate II, figure 1.

C.N.H.M. 46566 (1 adult, 77 mm. long): Gulf of Mexico, off southern Florida, trawled by the *Oregon* at Sta. 33, 25° 55' N. Lat., 83° 53' W. Long., depth 62 fathoms, June 24, 1950.

C.N.H.M. 59898 (1 adult, 81.5 mm. long): Gulf of Mexico, off northern Florida, trawled by the *Oregon* at Sta. 916, 28° 23' N. Lat., 84° 49' W. Long., depth 37 fathoms, October 3, 1953.

C.N.H.M. 64369 (1 adult, 75.5 mm. long): off North Carolina, trawled by the *Combat* at Sta. C-384, 35° 54' N. Lat., 75° 25' W. Long., depth 75 fathoms, June 17, 1957.

Counts were made on all specimens examined, on both sides for bilateral structures. The variation found in scale counts is indicated in table 1. Following is the observed variation in ray counts, with number of specimens in parentheses: dorsal spines 13 (16), 14 (1); dorsal soft-rays, 17 (2), 18 (8), 19 (7); anal spines, 3 (17); anal soft-rays, 14 (2), 15 (14), 16 (1); principal caudal rays, 16 (1, with fourth ray from bottom more widely forked than usual), 17 (16); pectoral rays, not distinguishing unbranched and branched rays, 13—13 (1), 14—14 (10), 14—? (1), 14—15 (3), ?—15 (1); 15—15 (1); pelvic rays, I, 5—1, 5 (17).

Checking in sequence the description of *C. falcifer*, we noted the following characters on the specimens of *C. aya* listed above. The outermost pelvic soft-ray is produced into a short filament, about as in *C. falcifer*. In some specimens a few neuromast pits were observed on the scales of the midlateral row on the caudal peduncle, and on a few scales near the base of the peduncle, in a row extending upward and slightly forward. Other scales, scattered, bear such pits. Some of the scales in the row impinging above on the lateral line bear pits in some individuals. The scales across the top of the premaxillaries in front of the rostral fold vary from none to a band covering about half the exposed width of the premaxillaries. The groove from the nostrils to the rostral fold is variously scaled over. Variable also is the degree of scalelessness and of bony tuberculation on the small triangular area above and behind the bony orbital rim. The length of the gape varies from considerably less than half to a little more than half the length of the upper jaw. The bony ridge between the upper orbital border and the posterior nostril may be detached or scarcely developed, but may also extend nearly to the nostril. In most specimens the narrow fleshy upper orbital rim, more or less protruding from the bony rim, is devoid of scales, perhaps as the result of loss, because in some examples this margin bears spiny scales. In some individuals this fleshy rim is scarcely apparent. Especially in the fish preserved in alcohol, and therefore retaining guanin, the rear border or even both edges of the band above the eye and both borders of the posterior bar are abruptly margined by a light streak. In the squamation of the caudal fin *C. aya* may differ from *C. falcifer*, but the loss of scales on this fin is difficult to appraise. In a few specimens strongly etenoid scales cover most of the caudal fin, except along the posterior margin, but in general such scales are confined to the basal part of the fin and the scales that may

have been lost have not left any conspicuous pockets. Except as noted above or in table 1, and except for internal characters and detailed measurements that were not taken, the description of *C. falcifer* applies quite well to *C. aya*.

Chaetodon marcellae Poll.

(Plate II, figure 2.)

Chaetodon (Orychaetodon) marcellae POLL, 1950 (November): 2-7, fig. 1 (original description; comparisons; 25 miles southwest of Pointe de Banda, west Africa, at 3° 57.5' S. Lat., 10° 36.5' E. Long.).

Chaetodon altipinnis CADENAT, "1950" (but on rear cover is indication of publication in 1951, as follows: "dépôt légal 1951, 1^{er} trimestre, n° 236"): 239, 307, 315, 318, fig. 174 (original diagnosis; Sénégal).

This interesting species was described almost simultaneously by Poll and by Cadenat. Poll has advised us that his publication actually did appear in 1950. It is obviously a very close relative of the western-Atlantic *Chaetodon aya*. In fact, the only really sharp difference that is apparent on comparing Poll's description and figure with *C. aya* lies in the position of the posterior dark bar, which originates near the end instead of near the middle of the soft dorsal and is nearly vertical instead of rather strongly oblique (compare plate II, figure 1 and plate III, figure 1, with plate II, figure 2). This is obviously an adequate distinction.

Poll referred *marcellae* to the Indo-Pacific subgenus *Orychaetodon*, but the agreement is not close. He failed to appreciate the intimate relationship with *C. aya*, which until now has not been figured, and which Ahl referred to the subgenus *Chaetodontops*.

Chaetodon marcellae, like *C. aya* and *C. falcifer*, is obviously a relatively deep-water species. The type was taken far offshore at a depth of 85 meters, on a bottom of sandy brown mud.

This species may be included among the not inconsiderable number of essentially New World types that has become established in tropical west Africa (p. 308).

Prognathodes aculeatus (Poey).

(Plate III, figure 2.)

Chelmon aculeatus POEY, 1860 (July): 202-203 (original description; rare; Cuba).

Prognathodes aculeatus POEY, 1868: 354 (reference; characters). EIGENMANN and HORNING, 1887: 2-3 (diagnosis; relations; after Günther and Poey). JORDAN and EVERMANN, 1898: 1671 (description; synonymy; after Günther and Poey). AHL, 1923: 11 (synonymy; relations; description; West Indies; Havana, Cuba).

Prognathodus aculeatus BLEEKER, 1876a: 303, 1876b: 315, and 1877: 32, 34 (characters; genus; synonymy).

Chelmo pelta GÜNTHER, 1860 (September): 38 (original description; locality uncertain).

As the synonymy indicates, this species was originally associated with *Chelmon*. Ever since the genus *Prognathodes* was based on this species by Gill (1862: 238), it has been regarded as a close relative of the Indo-Pacific genera *Chelmon*, *Chelmonops*, and *Forcipiger*, obviously on the basis of the beaklike modification of the muzzle in all four genera. But those three genera have the lateral line of the *Heniochus* type (continuous to the caudal base), whereas in *Prognathodes aculeatus* the lateral line ends, as in *Chaetodon aya*, under the anterior part of the soft-dorsal fin, only about one scale row from the structural base of the rays. Since we regard the lateral-line character as of prime taxonomic significance, we interpret *Chelmon*, *Chelmonops*, and *Forcipiger* as modifications of a primitive member of the *Heniochus* series, and *Prognathodes* as only a parallel modification of *Chaetodon*.

In fact, *Prognathodes aculeatus* appears to have arisen from *Chaetodon aya* or from a very similar, related species. This view was anticipated by Hildebrand in his estimate of *C. aya* as being rather intermediate between more ordinary species of *Chaetodon* and *Prognathodes*. The many points of resemblance between *Prognathodes aculeatus* and *Chaetodon aya* can hardly be fortuitous. In its beaklike modification *P. aculeatus* merely exaggerates the characters of *C. aya*. In squamation, body form, extremely strong and greatly excised fin spines, and other respects, the two species are remarkably alike (see plate II). Even the fin formula is approximately the same (the type of *P. aculeatus* has XIII, 19 dorsal, III, 15 anal, 17 caudal, 14—14 pectoral, and I, 5 — I, 5 pelvic rays. Each species has finely denticulate bones around the orbit and has the muzzle well sealed forward to the rostral edge, with a more or less scaleless groove from nostril to the rostral fold, and the chin well sealed almost to its front. Each has the preopercular and scapular edges finely denticulate. In each the lateral line ends under the anterior part of the soft dorsal, as is noted above. The dark band through the eye is very similar.

Although the two forms are so much alike, there can be no doubt that *P. aculeatus* is at least specifically distinct from *C. aya*. It differs from *C. aya* not only in the much more modified beak, as described below, but also in other respects. For instance, the posterior dark bar is apparently lacking, and the caudal peduncle is slenderer (least depth is less instead of more than one-fourth the length of the head).

In view of the definite approach to *Prognathodes* of some species of *Chaetodon*, notably *C. falcifer*, *C. aya*, and *C. marcellae*, some ichthyologists may not wish to retain *Prognathodes* as a distinct genus. The only known differences lie in the beak structure. The jaws are slenderer and more produced. The upper lip instead of covering much of the premaxillaries is confined to the extreme edge, leaving nearly all of the exposed premaxillary

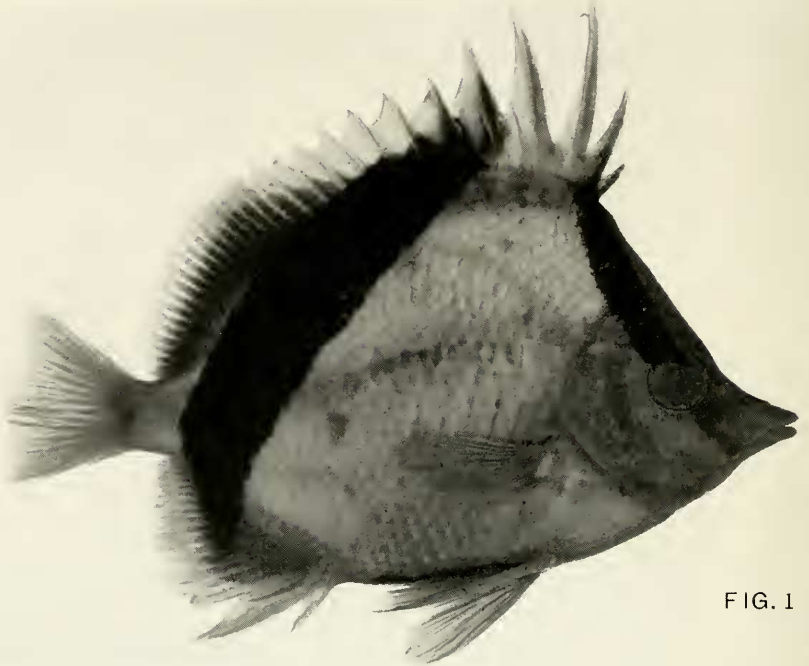


FIG. 1

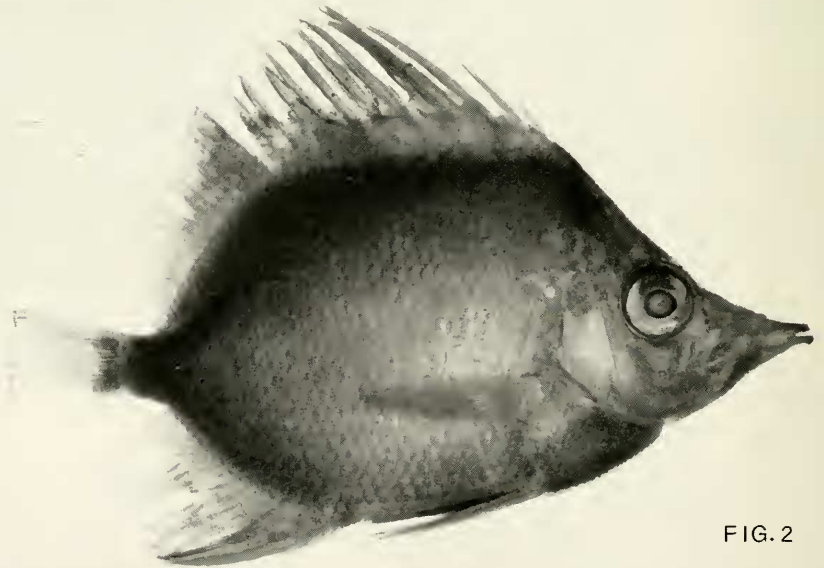


FIG. 2

surface smooth, bony, and scaleless, rather than rough, fleshy, and more or less scaled. Pending a more general study of the whole group, we suggest that *Prognathodes* be retained as a monotypic genus.

The only specimen of *P. aculeatus* that we have located is U.S.N.M. 4716. It is labelled as from "Cuba, Prof. F. Poey," and it bears Felipe Poey's original number 56. Although it seems slightly smaller than the specimen described by Poey (61 mm. in standard length, 73 mm. to the somewhat broken tip of the caudal, rather than 80 mm.) it is regarded as the holotype of *Chelmon aculeatus* Poey, and has been so designated in the National Museum records (Poey's measurement may have been rounded out to 80 mm. and the specimen may have shrunk slightly since he measured it; restored, the total length would probably slightly exceed 75 mm.). The specimen was entered as *Prognathodes pelta* and is no doubt the one Gill examined when he described the genus, designating *P. pelta* as the type species. It is shown as plate III, figure 2.

SYSTEMATIC AND ZOOGEOGRAPHICAL CONCLUSIONS

Chaetodon falcifer is described as a strikingly distinct new species of butterflyfish from rather deep water at Guadalupe Island, an oceanic island in the Pacific Ocean well off the coast of Baja California. It is regarded as probably an endemic species, in an island fauna marked by a high incidence of endemism. It is, however, a deep-water form, which may have escaped attention elsewhere.

Whether endemic or not on Guadalupe Island, *C. falcifer* ranks as one of the tropical elements in the mixed tropical and temperate fauna of this island. Currently, it is probably the northernmost representative of the Chaetodontidae in the eastern Pacific. There are apparently reliable indications, however, that *Chaetodon humeralis* ranged north to San Diego during the warm period approximately one hundred years ago.

The closest relatives of *C. falcifer* appear, on the basis of similar morphology and of the distinctively deep-water habitat, to be two Atlantic species, *C. aya* of the western North Atlantic and *C. marcellae* of tropical west Africa. The West Indian *Prognathodes aculeatus* appears to be a derivative of *C. aya* (or of a closely related species), differing in the more extreme modification of the beak. These circumstances illustrate two zoogeographical

PLATE III

Figure 1. *Chaetodon aya* Jordan, from adult (U.S.N.M. 151980) 98.5 mm. long, trawled off Long Bay, South Carolina, at a depth of 40-45 fathoms. Photo by United States National Museum.

Figure 2. Holotype of *Chelmon aculeatus* Poey = *Prognathodes aculeatus* (Poey), a specimen (U.S.N.M. 4716) 61 mm. in standard length. Photo by United States National Museum.

tendencies that are being increasingly indicated by critical taxonomic studies; namely, (1) the tendency for New World fishes to possess a marked independence and integrity, indicative of lines of evolution essentially distinct from those of related Old World types, and (2) the tendency for New World types to be sparingly but definitely represented in the fauna of tropical west Africa.

In the classification of the Chaetodontidae far too much emphasis has been placed on the beaklike modification, such as is exhibited to a moderate degree by the species *C. falcifer*, *C. aya*, and *C. marcellae*, and, much more strikingly, by *Prognathodes aculeatus*. Thus, *P. aculeatus* has been consistently associated with the recognized genera *Chelmon*, *Chelmonops*, and *Forcipiger* because of the similar beakline feature, but those genera have a more primitive and more complete lateral line and appear to have stemmed from the *Heniochus* group, whereas *Prognathodes* is rather clearly a derivative of *Chaetodon*. Genera in several other families of coral-reef fishes, for example, *Lo* among the Siganidae and *Gomphosus* among the Labridae, have developed a similar beak, which seems to be a modification for plucking food out of generally inaccessible crevices, on the notably overgrazed coral reefs. This is one of many examples among fishes of a nutritional character that has been overemphasized in taxonomy, but which is much subject to parallel and convergent evolution.

It seems rather clear that the beak was independently evolved in the chaetodontines with an incomplete lateral line and in those with a complete line. The species *Chaetodon falcifer*, *C. aya*, *C. marcellae*, and *Prognathodes aculeatus* probably constitute one such phyletic line, but other species of *Chaetodon* with an incipient beak, such as those referred to subgenus *Oxychaetodon*, are likely of separate origin. Of the beaked chaetodontines with a complete lateral line, we see no assurance that *Chelmon*, *Chelmonops*, and *Forcipiger* represent a single natural group. Certainly Bleeker, Ahl, Jordan, and other students have erred in classing together all chaetodontids with a beak.

The lateral-line character appears to be of greater significance as an index of phylogeny in the group. On the basis of its simpler, more complete and more primitive lateral line, the eastern Pacific species *Chaetodon nigrirostris* is referred to the *Heniochus* series, tentatively to the genus *Heniochus*. *Heniochus nigrirostris* and *Forcipiger longirostris* are the only New World members of this series, and in the western hemisphere they are confined to the Pacific. They presumably represent, respectively, relatively old and new migrants, from the vast Indo-Pacific fauna, that have crossed the east-Pacific barrier. The Chaetodontinae as a whole are chiefly Indo-Pacific.

On these interpretations the high specialization of most species of *Henio-*

ochus and of *Chelmon*, *Chelmonops*, and *Forcipiger* is coupled with a basically primitive feature in lateral-line structure. This view is consistent with the increasingly evident generalization that specialized and primitive characters tend to be combined.

Various anatomical details will apparently prove of value in the much-needed generic revision of the family. Some characters of this sort are pointed out for the four species of chaetodontines now known from the eastern Pacific.

The lateral-line distinctions are repeated in the Pomacanthinae, and it is conceivable that they may be of greater phylogenetic significance than the enlarged head spines recognized as diagnostic of that subfamily. The primary divergence in the family may have involved the lateral-line character, and each division may have developed one or more enlarged head spines. If this view should prevail, the Pomacanthinae would appear to be a polyphyletic group, presumably not worthy of subfamily recognition. We see no justification for the elevation of the group to family rank (Pomacanthidae), as proposed by Smith (1955), even though we assume it to be a natural assemblage.

Obviously there has been independent and convergent evolution either in the head-spine or lateral-line characters. On available evidence a decision as to which character is of more primary significance seems arbitrary. Such a situation is often encountered when taxonomic evidence in ichthyology is viewed afresh and critically.

LITERATURE CITED

ANL, ERNST

1923. Zur Kenntnis der Knochenfischfamilie Chaetodontidae, insbesondere der Unterfamilie Chaetodontinae. *Archiv für Naturgeschichte*, Abt. A, 89 (5):1-205, pls. 1-3.

BLEEKER, PIETER

- 1876a. Systema percarum revisum. Pars II. *Archives Néerlandaises des Sciences exactes et naturelles*, sér. B, Sciences naturelles, 11:289-340.
- 1876b. Notice sur les genres et sur les espèces des Chétodontoïdes de la sous-famille des Taurichthyiformes. *Verlagen en Mededeelingen der Koninklijke Akademie van Wetenschappen, Amsterdam, Afdeling Natuurkunde*, ser. 2, 10(3):308-320.
1877. Révision des espèces insulindiennes de la famille des Chétodontoïdes. *Verhandelingen der Koninklijke Akademie van Wetenschappen, Amsterdam, Afdeling Natuurkunde*, 17:1-174.
1878. Atlas ichthyologique des Indes Orientales Néerlandaises. Vol. 9:1-80, pls. 355-420. Frédéric Muller, Amsterdam.

BLOCH, MARC ÉLIÉSER

1796. Ichthyologie ou histoire naturelle des Poissons. Part 4: 969-1291; part 6: pls. 109-216. Berlin.

BREDER, CHARLES M., JR.

1929. Field book of marine fishes of the Atlantic coast from Labrador to Texas. i-xxxvii, 1-332, many figs. G. P. Putnam's Sons, New York and London.

BRIGGS, JOHN C.

1955. A monograph of the clingfishes (order Xenopterygii). *Stanford Ichthyological Bulletin*, 6:i-iv, 1-224, figs. 1-114, maps 1-15.

CADENAT, J.

- "1950" (1951). Poissons de mer du Sénégal. Initiations africaines, III. 1-345, figs. 1-241. Institut français d'Afrique Noir, Dakar.

CUVIER and VALENCIENNES

1831. Histoire naturelle des Poissons. Vol. 7:i-xxix + 5 + 1-531, pls. 170-208. Paris.

EIGENMANN, CARL H., and JENNIE E. HORNING

1887. A review of the Chaetodontidae of North America. *Annals of the New York Academy of Sciences*, 4(7-8):1-18.

EKMAN, SVEN

1953. Zoogeography of the sea. i-xiv, 1-417, figs. 1-121. Sidgwick and Jackson, Limited, London.

FOWLER, HENRY W.

1928. The fishes of Oceania. *Memoirs of the Bernice P. Bishop Museum*, 10: i-iii, 1-540, figs. 1-82, pls. 1-49.

FOWLER, HENRY W., and BARTON A. BEAN

1929. The fishes of the series Caprifformes, Ehippiformes, and Squamipennes, collected by the United States Bureau of Fisheries Steamer "Albatross," chiefly in Philippine seas and adjacent waters. *United States National Museum, Bulletin* 100, Vol. 8:i-xi, 1-352, figs. 1-25.

FRASER-BRUNNER, A.

1933. A revision of the chaetodont fishes of the subfamily Pomacanthinae. *Proceedings of the Zoological Society of London*, 1933:543-599, figs. 1-29, pl. 1.

1945. On the systematic position of a fish, *Microcanthus strigatus* (C. & V.). *Annals and Magazine of Natural History*, ser. 11, 12(91):462-468, figs. 1-3.

GILBERT, CHARLES H., and EDWIN C. STARKS

1904. The fishes of Panama Bay. *Memoirs of the California Academy of Sciences*, 4:1-304, pls. 1-33.

GILL, THEODORE

1862. Remarks on the relations of the genera and other groups of Cuban fishes. *Proceedings of the Academy of Natural Sciences of Philadelphia*, [vol. 14] 1862(5):235-242.

GIRARD, CHARLES

1858. Fishes. General report upon the zoology of the several Pacific railroad routes. Part 4:i-xiv, 1-400, 21 pls. *In* Reports of explorations and surveys . . . for a railroad from the Mississippi River to the Pacific Ocean, vol. 10. U. S. Senate Ex. Doc. no. 78, 33d Congress, 2d Session, Washington.

GÜNTHER, ALBERT

1860. Catalogue of the acanthopterygian fishes in the collection of the British Museum. Squamipinnes, Cirrhitidae, Triglidae, Trachinidae, Sciaenidae, Polynemidae, Sphyrænidae, Trichiuridae, Scombridae, Carangidae, Xiphiidae. Vol. 2:i-xxi, 1-548, 1 fig. London.
1868. An account of the fishes of the states of Central America, based on collections made by Capt. J. M. Dow, F. Godman, Esq., and O. Salvin, Esq. *Transactions of the Zoological Society of London*, 6(7):377-494, pls. 63-87.

HERRE, ALBERT W., and HERACLIO R. MONTALBAN

1927. The Philippine butterfly fishes and their allies. *The Philippine Journal of Science*, 34(1):1-113, pls. 1-24.

HUBBS, CARL L.

1946. An arm protractor for the precise measurement of angles in systematic ichthyology. *Copeia*, 1946 (2):79-80, fig. 1.
1948. Changes in the fish fauna of western North America correlated with changes in ocean temperatures. *Journal of Marine Research*, 7(3):459-482, figs. 1-6.

HUBBS, CARL L., and KARL F. LAGLER

1952. Fishes of the Great Lakes region. *Cranbrook Institute of Science, Bulletin* 26:i-xi, 1-186, figs. 1-251 + 38, 26 col. pls., 1 map.

JORDAN, DAVID S.

1886. Notes on some fishes collected at Pensacola by Mr. Silas Stearns, with descriptions of one new species (*Chaetodon aya*). *Proceedings of the United States National Museum*. 9:225-229.

JORDAN, DAVID STARR, and BARTON WARREN EVERMANN

1898. The fishes of North and Middle America: a descriptive catalogue of the species of fish-like vertebrates found in the waters of North America, north of the Isthmus of Panama. *United States National Museum, Bulletin* 47(2):i-xxx, 1241-2183, 1 fig.
1900. The fishes of North and Middle America. . . . *United States National Museum, Bulletin* 47(4):i-ci, 3137-3313, pls. 1-392.

JORDAN, DAVID STARR, and BARTON WARREN EVERMANN—Cont.

1905. The shore fishes of the Hawaiian Islands, with a general account of the fish fauna. *Bulletin of the United States Fish Commission*, for 1903, 23 (1):i-xxviii, 1-574, figs. 1-229, pls. 1-65, col. pls. 1-73.

JORDAN, DAVID STARR, and HENRY W. FOWLER

1902. A review of the Chaetodontidae and related families of fishes found in the waters of Japan. *Proceedings of the United States National Museum*, 25:513-563, figs. 1-6.

JORDAN, DAVID STARR, and ALVIN SEALE

1906. The fishes of Samoa. Description of the species found in the archipelago, with a provisional check-list of the fishes of Oceania. *Bulletin of the [United States] Bureau of Fisheries*, [for] 1905, 25:173-455, figs. 1-111, pls. 33-37, col. pls. 38-53.

KENDALL, WILLIAM C., and EDMUND L. GOLDSBOROUGH

1911. Reports on the scientific results of the expedition to the tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross," from August, 1899, to March, 1900, Commander Jefferson S. Moser, U.S.N., commanding. XIII. The shore fishes. *Memoirs of the Museum of Comparative Zoölogy at Harvard College*, 26:241-344, pls. 1-7.

LONGLEY, WILLIAM H., and SAMUEL F. HILDEBRAND

1941. Systematic catalogue of the fishes of Tortugas, Florida, with observations on color, habits, and local distribution. *Carnegie Institution of Washington Publication* 535, *Papers from the Tortugas Laboratory*, 34: i-xiii, 1-331, pls. 1-34.

MEEK, SETH E., and SAMUEL F. HILDEBRAND

1928. The marine fishes of Panama. *Field Museum of Natural History, Publication* 249, Zool. ser., 15(3):xxv-xxxii, 709-1045, pls. 72-102.

MUNRO, IAN S. R.

1955. The marine and fresh water fishes of Ceylon, i-xvi, 1-351, figs. 1-19, pls. 1-56. Department of External Affairs, Canberra.

MYERS, GEORGE S.

1941. The fish fauna of the Pacific Ocean, with especial reference to zoögeographical regions and distribution as they affect the international aspects of the fisheries. *Proceedings of the Sixth Pacific Science Congress of the Pacific Science Association Held at the University of California, Berkeley, Stanford University, and San Francisco, July 24th to August 12th, 1939*, 3, "1940":201-210.

NICHOLS, J. T., and F. E. FIRTH

1939. Rare fishes off the Atlantic coast, including a new grammicolepid. *Proceedings of the Biological Society of Washington*, 52:85-88, fig. 1.

POEY, FELIPE

1860. Memorias sobre la historia natural de la isla de Cuba, acompañadas de sumarios latinos y extractos en francés. Vol. 2(3):97-336, pls. 10-12, 14, Habana.

POEY, FELIPE—Cont.

1868. Synopsis piscium cubensium. Repertorio fisico-natural de la isla de Cuba, 2:279-484 (reprinted, in same year, with same pagination and with added title, Catálogo razonado de los peces de la isla de Cuba).

POLL, MAX

1950. Description de deux Poissons percomorphes nouveaux des eaux cotières de l'Atlantique Sud (1948-1949). *Institut royal des Sciences naturelles de Belgique. Bulletin* 26(49):1-14, figs. 1-2.

SCHULTZ, LEONARD P.

1951. *Chaetodon tinkeri*, a new species of butterflyfish (Chaetodontidae) from the Hawaiian Islands. *Proceedings of the United States National Museum*, 101:485-488, fig. 94, pl. 15.

SMITH, J. L. B.

1955. The fishes of the family Pomacanthidae in the western Indian Ocean. *Annals and Magazine of Natural History*, ser. 12, 8(89):377-384, pls. 4-5.

STEARNS, SILAS

1887. The fishing-grounds of the Gulf of Mexico belonging to the United States. 55-58, charts 16-17. *In Fisheries and Fishery Industries of the United States*, by George Brown Goode and associates. Sect. 3. United States Commission of Fish and Fisheries, Washington.

WEBER, MAX, and L. F. DE BEAUFORT

1936. The fishes of the Indo-Australian Archipelago. Perciformes (continued). Families: Chaetodontidae, Toxotidae, Monodactylidae, Pempheridae, Kyphosidae, Lutjanidae, Lobotidae, Sparidae, Nandidae, Sciaenidae, Malacanthidae, Cepolidae. Vol. 7:i-xvi, 1-607, figs. 1-106. E. J. Brill, Leiden.

WOODS, LOREN P.

1953. Subfamily Chaetodontinae. 566-596, pls. 49-58. *In Fishes of the Marshall and Marianas islands: Asymmetriontidae through Siganidae*, by Leonard P. Schultz and collaborators, *United States National Museum, Bulletin* 202, vol. 1.